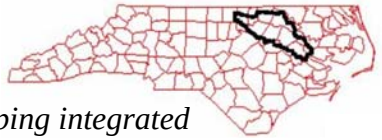
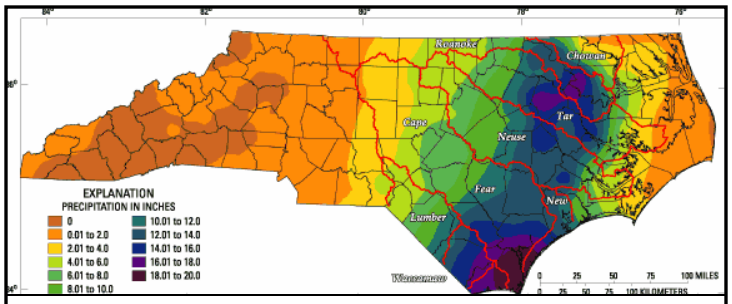
Coastal and Inland FLooding Observation and Warning (CI-FLOW) Project



A unique inter-disciplinary multi-agency consortium developing integrated water services for the nation from the Sky to the Summit to the Sea

Hurricane/Tropical Storm Dennis (Sept. 3-7,1999) and Hurricane Floyd (Sept. 15-16,1999) caused catastrophic flooding in North Carolina during September of 1999. Combined rain totals from the two storms over 10 days in the Tar River basin of North Carolina were between 20 and 25 inches. Creeks rose 6 to 8 inches per hour, pushing river levels to 500-year event heights. Floyd claimed 51 lives, mostly due to inland flooding. Thousands were left homeless. FEMA documented 6 million dollar losses to businesses and agriculture. Long-lasting effects on regional infrastructure included warnings not to drink or bathe in water from taps for fear that it may harbor dangerously high levels of fecal coliform bacteria.

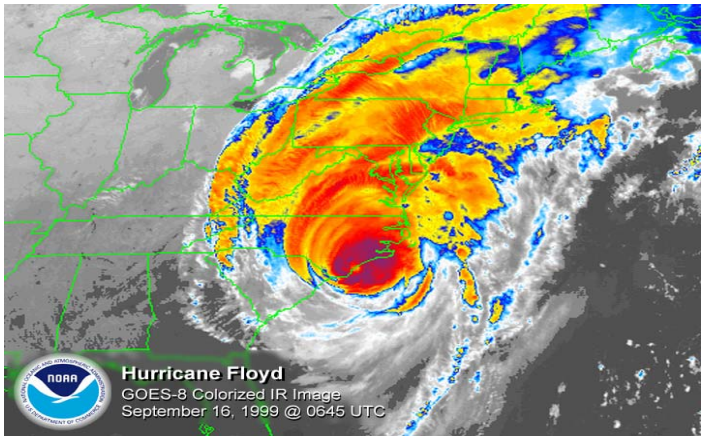


Hurricane Floyd Rainfall (North Carolina State Climate Office)
At Rocky Mount, in the middle portion of the Tar River basin, 10.38 inches of rain fell in 12 hours. Storm total reports for Floyd in Rocky Mount ranged from 14.07 to 18 inches. For the 21 day period ending at 8AM EST on Sept 18, 1999, rainfall reports totaled 23.99 inches at Rocky Mount, 22.24 inches at Greenville, and 17.81 inches at Tarboro, primarily due to Floyd and Dennis.

Vision Expands

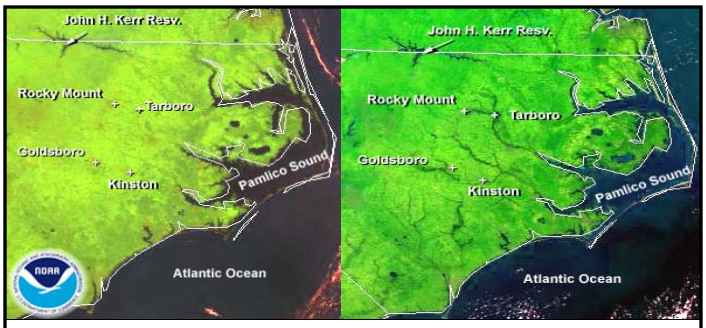
This CI-FLOW vision has captured the interest of other NOAA groups operating programs in the Carolinas including local National Weather Service (NWS) offices, NWS Office of Hydrologic Development (OHD), National Environmental Satellite Data and Information Service (NESDIS), and the Coastal Services Center. The CI-FLOW approach to water information is also establishing a firm foundation for cooperation and collaboration with other federal, state, academic, and tribal agencies and governments and NOAA's **C**oastal **E**stuary **R**iver **I**nformation **S**ystem (CERIS) through its primary project goals of:

- Advanced Automated Hydrologic Precipitation Estimation
- Advanced Hydrologic and Estuary Modeling Techniques
- Introduction of Water Quality Forecasts
- Improved Forecasts of Water Levels for Marine Operations



Genesis of CI-FLOW Project

In response to these devastating events, NOAA launched the CI-FLOW project. CI-FLOW is a research and demonstration project for the evaluation and testing of new technologies and techniques to produce accurate and timely identification of inland and coastal floods and flash floods in the Tar-Pamlico basin. Pioneer CI-FLOW partners in February 2000 included the National Severe Storms Laboratory (NSSL), National Sea Grant (NSG) College Program, the University of Oklahoma, and North and South Carolina Sea Grant programs. North Carolina State University (NCSU) soon followed. This unique research collaboration inspired a model to work across NOAA with university partners to develop a truly integrated interdisciplinary water services program focused in improving the delivery of water information to Carolina communities.



NOAA 15 Satellite: Images of Pre-Flood River (7/31/99) (left) and River Flooding Conditions (9/18/99) (right)
Note the darkened areas indicating excessive flood waters within the coastal watersheds of North Carolina

Flooding is the number one hazardous weather-related killer in the U.S. The CI-FLOW research efforts will reduce the loss of life and property from hydrologic hazards in the Carolinas and across our nation.

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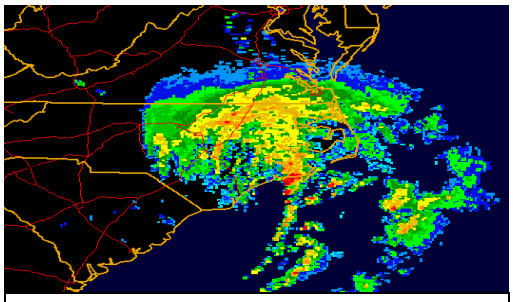
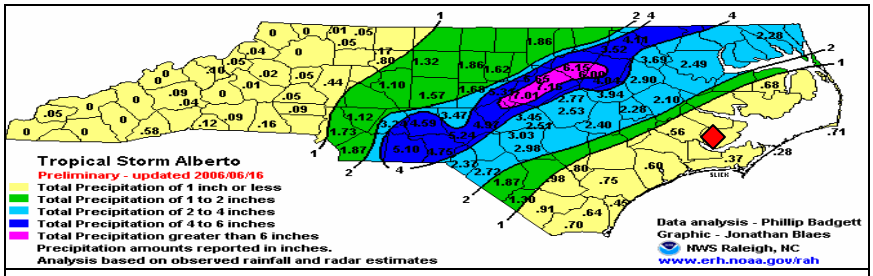
CI-FLOW activities will demonstrate the value of an integrated scientific, technological, and information framework to provide water quantity and quality information from the sky…to the summit…to the sea.

The Sky…

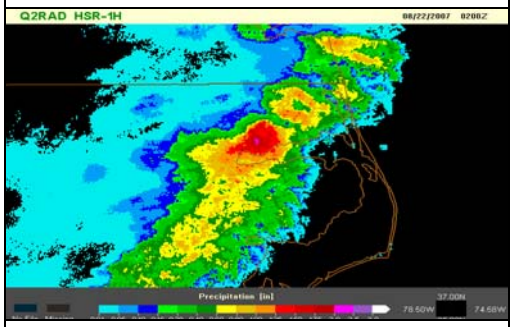
The atmosphere above the Tar River Basin will be scrutinized with remote and *in-situ* observing techniques pioneered by CI-FLOW partners. The goal is to produce the most accurate automated multi-sensor Quantitative Precipitation Estimate (QPE) for the Tar River Basin every 5 minutes on a 1-km spatial scale. The CI-FLOW multi-sensor QPE will incorporate information gathered from the multiple radars, rain gauges, satellites, numerical weather models, and lightning detection networks monitoring the basin to provide a continuous assessment of precipitation falling onto the watershed. CI-FLOW will leverage scientific expertise from three ongoing NOAA research activities namely the NSSL NMQ/Q2 (www.nmq.nssl.noaa.gov), the NWS/OHD MPE/EMPE program, and the NESDIS HydroEstimator program.



Morehead City NEXRAD Composite Reflectivity
June 14, 2006 1623 UTC



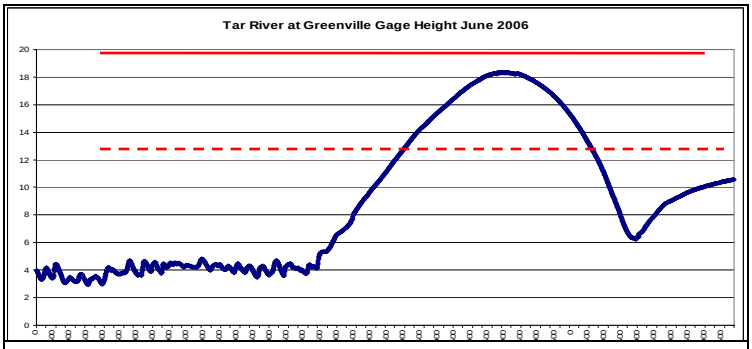
Rainfall Totals June 13-15, 2006 Tropical Storm Alberto
Upper reaches of the Tar River received over 6 inches of rainfall
(Red diamond denotes location of Greenville river gauge, a National Weather Service forecast point just above the junction of the Tar River with the Pamlico Sound)



NSSL Q2 QPE 1 Hour Rain Rate Product
The Q2 system currently monitors the Tar River basin

The Summit…

From the headwaters of the Tar River on the Piedmont plateau to the Pamlico Sound, water quantity and quality will be monitored and predicted using an ensemble of high-resolution models. Each model will create its own unique streamflow simulation dependent on channel characteristics, soil type, the slope of the land, and vegetation patterns. These simulations will be input into CI-FLOW water quality models to provide forecasters multiple solutions regarding timing and river discharge for multiple forecast points in the basin. Improved information on water quantity and quality is critical to Tar River hydrologic hazard mitigation programs.



Response of Tar River at Greenville from Alberto Rainfall
At Greenville, the Tar River rose to a crest of 18.35 ft. at daybreak June 21, 2006
(Dashed red line = flood stage 13 ft., solid red line = major flood stage 19 ft.)

The Sea…

The Tar-Pamlico river basin meets the Atlantic Ocean in the Pamlico Sound, where the impacts of coastal storms on densely populated areas create tremendous economic impacts. U.S. Census data indicates over half of our nation's population, 153 million people, live in coastal counties, and an estimated 12 million more are expected to move to the coasts by 2015. CI-FLOW research will demonstrate the value of incorporating storm surge and wind characteristics in coastal watershed streamflow predictions. Ensembles of storm surge models currently operating in Carolina academic institutions and at the NOAA Tropical Prediction Center and NWS Southeast River Forecast Center will be coupled with the ensemble of water quantity and quality models to help improve forecasts for these areas.

Image of North Carolina Outer Banks and Pamlico Sound
Expanding coastal communities, like those on North Carolina barrier islands, are vulnerable to storm surge on seaward shores and freshwater flooding on bayside shores as inland rivers, like the Tar River, transport floodwaters downstream

The CI-FLOW Project's efforts to integrate coastal storm effects, specifically heavy rainfall, storm surge, and antecedent river conditions, to improve water information will provide valuable information to the development and successful implementation of a Coastal Estuary River Information System (CERIS): A NOAA South Atlantic Region Team/ Integrated Water Resource Services Priority Area Task Team collaboration.